SOME TRENDS IN THE COTTONSEED CRUSHING INDUSTRY

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Thank you very much, Mr. Chairman, Members and Guests of the National Cottonseed Products Association.

I consider it a rare privilege to be invited to speak on the occasion of your Fiftieth Anniversary. This is certainly an eventful day in the history of an association that is of great importance to the agriculture and the industry of the South. May I express my congratulations to you and wish you many, many more years of achievement and prosperity. I should like also to express appreciation for the support and cooperation which this Association has given our Bureau over the past twenty or more years, particularly in respect to our relationship with your Technical Advisory Committee. Mr. E. R. Barrow and the members of his Committee have been of great help to our Bureau in conducting research of mutual interest to us and to this Association. I understand that the Technical Advisory Committee is now celebrating its twenty-fifth birthday, and this I think, is also an event that should be noted, because of the valuable services rendered by this Committee in the development of the industry. I hope that this Committee and our Bureau may continue to have the same fine relationships that have existed for so many years.

I feel quite humble in appearing before this Society to address you on such a subject as "Trends in the Cottonseed Crushing Industry." Certainly, there are many people in this audience who are far better informed on the on the subject and better qualified to discuss it. Therefore, I ask you to bear with me as I attempt to develop some of the background by reviewing facts which, no doubt, have long been common knowledge to most of you.

Although cottonseed was crushed for oil prior to 1870, the industry was hardly well established until about that date. Some seven oil mills were in operation, I understand, as far back as 1865, and by 1870 this number had increased to perhaps twenty-six mills. When this Association was founded, in 1897, there were probably in the neighborhood of 300 mills in operation. A phenomenal growth did take place in the crushing industry during the period 1870 to 1914, when the number of mills rose to 885.

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I should like, if I may, to present a few data which will show the development of this industry, particularly with regard to the number of mills that have been in operation during the years from 1909 until the present time, and also to indicate changes in the quantity of seed crushed by these mills in that period. These data which have been assembled by Dr. K. S. Markley, of the Bureau's Southern Regional Research Laboratory here in New Orleans, cover a 35-year period and, I think, will be of interest to you.

It is interesting to note that the production of oil and meal during this period of 35 years has not followed directly the number of mills that were in operation. I want to emphasize that point as you review the tabular data in Table I (page 3).

Beginning in 1909, as you see in the table, there were about 810 active mills in operation, with a total crush of a little over 3 million tons of cottonseed. The columns at the right present data on the quantity of crude oil produced, on the quantity of cake and meal, and on the hulls. I would like to call your attention to the left-hand columns of the Table, which show that after 1909 the number of mills in operation increased progressively up to 1914, when there was a peak of 885 mills. The crush that year was 5,780,000 tons. After 1914, the number of mills began to go down a little, and by 1918 only 727 mills were in operation, although the crush was still fairly well up to the peak.

I think perhaps the most significant figures are the averages for the 10-year periods. For the decade ending in 1918, there was an average of 813 mills in operation, with an average annual crush of 4,491,000 tons.

During the second 10-year period, you will notice, the number of mills fell progressively from 703 to 675, 667, and on down by 1928 to 545 mills - an average of 586 over this 10-year period. But you will observe that the annual crush remained the same as it was during the first 10-year period, with a total of 4,382,000 tons.

During the third 10-year period, the number of mills fell progressively from 520 in 1929 to 510, 500, 495, and so on down to 462 in 1938. The average for this period was 486. The average crush was 4,641,000 tons, which was some 300,000 tons higher than the prior 10-year period, although there were a hundred mills less during the period.

During the 5-year period, 1939-1943, which included the latest year for which there are official data on crushing, the number of mills continued to fall off, coming down to 394 in 1943; the average, however, was 424, and the crush still held up at 4,242,000 tons.

In summarizing, I want to point out the downward trend so far as number of mills in operation is concerned. Starting out in 1909 at a little over 800, the number increased up to the peak of 885, and then declined over the period of 35 years, until in 1943 there were a little under 400 mills. Today, some 360 mills are in operation, which shows that the trend has continued downward. Nevertheless, the average annual crush per 10-year period has been practically the same throughout all this time, decreasing slightly

Table I

Active Cottonseed Oil Mills, Seed Crushed and Products Produced 1909-43

Year beginning August	No. of active mills[a/]	Quantity crushed	Crude oil	Cake and meal	Linters	Hulls
		1,000 tons	Million pounds	1,000 tons	1,000 running bales	1,000 tons
1909	810	3,269	982	1,326		1,289
1910	810	4,106	1,260	1,792		1,375
1911	839	4,921	1,512	2,151		1,642
1912	857	4,580	1,394	1,999		1,540
1913	870	4,848	1,450	2,220		1,400
1914	885	5,780	1,720	2,648		1,677
1915	844	4,202	1,254	1,923		1,220
1916	763	4,479	1,408	2,225		969
1917	728	4,252	1,212	2,068		996
1918	727	4,479	1,326	2,170		1,137
10 yr. average	813	4,491	1,352	2,052		1,324
1919	703	4,013	1,212	1,817		1,143
1920	675	4,069	1,310	1,786		1,256
1921	560	3,[illegible]3	930	1,355		937
1922	527	3,242	1,002	1,487		944
1923	532	3,308	980	1,518		941
1924	530	4,605	1,404	2,126		1,331
1925	563	5,558	1,718	2,597		1,547
1926	570	6,306	1,888	2,840	1,042	1,854
1927	557	4,654	1,477	2,093	875	1,320
1928	545	5,061	1,604	2,282	1,086	1,368
10 yr. average	586	4,382	1,352	1,990		1,264
1929	520	5,016	1,572	2,232	1,038	1,384
1930	510	4,715	1,442	2,165	824	1,304
1931	500	5,328	1,694	2,401	876	1,511
1932	495	4,621	1,446	2,093	741	1,312
1933	493	4,157	1,303	1,889	801	1,103
1934	478	3,550	1,109	1,614	805	913
1935	471	3,818	1,164	1,739	876	988
1936	461	4,498	1,364	2,031	1,127	1,144
1937	466	6,326	1,961	2,830	1,471	1,626
1938	462	4,471	1,409	2,023	1,113	1,161
10 yr. average	486	4,641	1,446	2,102	967	1,245
1939	446	4,151	1,325	1,882	1,072	1,055
1940	446	4,398	1,425	1,954	1,208	1,107
1941	426	4,008	1,250	1,753	1,184	992
1942	410	4,498	1,401	1,995	1,355	1,085
1943	394	3,[illegible]4	1,236	1,834	1,183	926
5 yr. average	424	4,242	1,327	1,883	1,200	1,033

a/ Data on number of active mills furnished by J. F. Moloney of the National Cottonseed Products Association.

for the second 10-year period, increasing in the third 10-year period and again decreasing a little in the next five years.

Of course, if we were to picture the crush for individual years, there would be wide variation, due to crop fluctuations over that period, but the 10-year averages, and even the 5-year average, I think, give a pretty fair picture of what the situation has been during the past 35 years, and what I presume may be expected to continue for some time.

During this period, there have been marked improvements in the industry. Many of you are well acquainted with the developments that have occurred. Away back in the 1890 to 1900 period, the hydraulic press was developed and more efficient methods of delinting and cooking were introduced, and shortly after the turn of the century the continuous screw press was developed and adopted. In spite of this development, the hydraulic press continues to be used for the major part of the cottonseed that is crushed.

The seasonal nature of the industry, which still continues to be one of its principal handicaps, and, the relatively inexpensive equipment required because of the short crushing season, have favored the hydraulic press. This situation has been remedied to some extent in mills which have undertaken the crushing of other seed. For example, a number of mills are now pressing peanuts and soybeans. Work is going forward on the development of improved storage methods for cottonseed, which may eventually be of some help.

I feel that the hydraulic pressing procedure is so well known to this audience that it is unnecessary to discuss that operation here. You are also acquainted with the several operating steps that are involved and probably recognize that the operation is not highly efficient, that it is costly in terms of power and in terms of labor, and that there is not the complete oil recovery which might be desired.

Similarly, I am sure that most of you are well acquainted with the expeller, or continuous-screw type of operation. Even those of you who may not have actually used it in your own plants have, I am sure, been in contact with it. And, of course, detailed information concerning expellers is readily available from manufacturers that put out such equipment.

With the expeller, or continuous-screw type of press, are accomplished practically all of the several operations that are involved in the press room of the hydraulic pressing plant. It is true that the seed must still be cleaned and delinted and cracked, and part of the hulls must be removed. Nonetheless, one continuous press is the equivalent of the crushing rolls and several hydraulic presses, and avoids the use of filter cloths, cutting down on labor and other costs.

Both types of press, when properly operated, can give a very good oil and a high grade of meal and cake. But there still remains in the cake obtained by either operation, a very substantial amount of oil which is sold, not at the price of oil, but at the price of meal. Residual oil ranges from 4-1/2 to 7 per cent. Moreover, the meal has lost some of its nutrient value, perhaps, through the denaturization of protein by heat.

Perhaps we may learn something from the oil industry in Europe, which has developed, of necessity, certain processes which are more efficient than those used in this country. As you know, production of oils in Europe is quite inadequate for its own demands, and over a period of years European oil millers have had to import large quantities of oil-bearing materials. They have imported many types of oilseeds, and they have developed mills which handle oil-bearing materials ranging in fat content from 15 to 60 per cent, with a maximum recovery. There are three general methods of oil recovery in use. The first is a solvent-extraction process; the second comprises fore-pressing and expelling, followed by solvent extraction; and the third comprises fore-pressing and expelling, followed by finishing in a cage press.

During the past year, Dr. Klare S. Markley, of our Southern Regional Research Laboratory, was detailed to go on a mission to investigate the vegetable-oil industry of Europe, particularly the oil refining and oil processing industry. He spent about three months abroad studying the industry quite thoroughly; as a result, he has prepared a number of reports, which, I understand, have recently been declassified from "confidential" and are now available to interested persons for examination. Dr. Markley has given me some of that information, which I want to read so that I may not deviate from the observations he made.

"Solvent extraction per se is applied to seeds of low oil content such as soybeans and for many years it was also applied in the recovery of cottonseed oil from hydraulic press cake imported from the United States. At one time, exports of cottonseed cake to Europe amounted to approximately three quarters of a million tons, annually. A large part of this cake was extracted in countercurrent batch extractors to recover the residual oil, and the extracted cake was then fed to live stock.

Solvent Extraction of Cottonseed

"Prior to World War II, many European oil mills imported cottonseed from Egypt and India and processed it by means of a combination of expeller forepressing and solvent extraction. Egyptian and Indian cottonseed received in Europe is free or practically free of linters and under these conditions can be handled and stored much like other oilseeds such as soybeans, sunflower, sesame, etc. High oil content seeds or kernels are generally forepressed in expellers in two stages to a fat content of 15 to 20 per cent and then solvent extracted. The expellers used for this process, although similar in external appearance to American expellers, are provided with a different type of expression chamber. The pressing chamber of the conventional European expeller or screw-press comprises a series of compartments of progressively reduced diameters connected by tapering compartments, the oblique internal surfaces of which have a damming action on the material passing from one compartment to the next. The thread of the worm is interrupted at the tapering passage so that the material progresses in these parts where it passes from one chamber to the next chamber of smaller volume and higher pressure. The surfaces exposed to friction decreases from chamber to chamber and the pressure increases.

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This type of construction makes possible the stepwise expression of high oil content seeds or kernels at relatively low pressures and correspondingly low frictional temperatures. Expellers of this type having capacities of 50 tons per day of high oil content seeds are approximately the same over-all dimensions as American expellers, but require considerably less power to operate. Several expellers having a capacity of 150 tons per day were constructed and operated in Germany during World War II. These expellers were used for pressing pulp but similar expellers are being designed for use on oilseeds. Their capacity will be about 10 times that of expellers commonly used in this country. When cottonseed is handled by the expeller forepressing solvent extraction method, it is first rolled and cooked at temperatures of 165° F. (75° C.) or slightly higher in stack cookers consisting generally of two but sometimes more than two stacks or kettles. The rolled meats are pressed in two stages, first to 25 to 30 per cent then to 15 to 20 per cent oil content after which they are re-rolled and solvent extracted either in countercurrent batch or continuous extractors to produce a meal having an oil content of one per cent or less. The meal produced in this process is superior for some purposes to that produced by the hydraulic or the high-pressure expeller process because it is subjected to relatively lower pressures and correspondingly lower temperatures. The oil obtained by forepressing is generally of higher quality for the same reason, and the oil subsequently extracted with solvent is superior to that obtained by direct solvent extraction because part of the pigments of the seed accompanies the expressed oil and part of the remainder is rendered insoluble.

"In contrast to European practice, attempts have been made in the United States to treat high oil content seeds, particularly cottonseed and peanuts, by direct solvent extraction without prior forepressing. Much effort has been expended in Europe during the past 30 years to solvent extract high-oil content seeds directly by a wide variety of batch and continuous processes, but none has been entirely satisfactory. If such a method could be developed it would simplify and reduce the cost of oil recovery from this type of oilseed."

This is the end of my quotation from Dr. Markley's report on the European vegetable oil industry. Now I want to tell you about some recent developments in the United States:

New Method of Cottonseed Processing

The Southern Regional Research Laboratory in New Orleans recently developed on a laboratory and semi-pilot-plant scale an entirely new and unique method of processing cottonseed. This process was developed as the result of an investigation of the pigments of cottonseed to determine their nature and possible method of removal from the seed.

Everyone who has examined a cottonseed, especially by the early method of grading, that is, by cutting it in two and examining the color of the kernel, or who has seen crude cottonseed oil run from the presses, has noted the blue-black coloration of the kernels and the red-to-black color of the

expressed oil. Despite the innumerable observations of the dark pigmentation of these products only one pigment, namely light yellow gossypol, had been isolated from cottonseed until recently. To it has been attributed the multitude of pigment problems associated with cottonseed and its products.

When the Southern Regional Laboratory began work on this problem about four years ago there was discovered in rapid succession a series of previously unrecognized pigments, three of which have been isolated and named, because of their colors and association with gossypol; gossypurpurin, a dark-purple pigment; gossyfulvin, an orange-yellow pigment; and gossycaerulin, a blue pigment. The last mentioned pigment has been found only in cooked cottonseed meats. Still more recently evidence has been obtained of the presence in cottonseed of no less than eleven pigments in addition to gossypol. Most of these pigments are found to reside in special organs of the cottonseed which are generally referred to as pigment glands. These glands, the blue-black dots observed in a section of cottonseed or in rolled uncooked meats, are walled-off bodies which appear to be unconnected with the remainder of the tissue of the kernel. In attempting to separate these pigment organs or glands from the surrounding tissue in order that the pigments contained therein might be investigated in the absence of the other constituents of the kernel, a process was developed whereby the kernel was separated into three fractions. In this process the cottonseed meats are rolled to form very thin flakes and then disintegrated by violent agitation in a liquid medium, which causes a separation by flotation into intact pigment glands, an oil-solvent mixture, and a meal free of oil and pigment glands. The disintegration and separation of the rolled meats into these three fractions is effected in a medium comprising a mixture of chlorinated and unchlorinated solvents adjusted to a density which allows the pigment glands to float to the surface and the meal to sink to the bottom, leaving the miscella or oil-solvent mixture as an intermediate phase between the other two. Since practically all of the pigments of the gossypol group are removed in the form of the intact glands, the meal and oil are relatively light-colored. The protein content of the meal is increased both by removal of the glands which amount to approximately three per cent of the weight of the meal, and by the nearly complete removal of the oil. Because of the practically complete removal of the gossypol pigments, the nutritional quality of the meal is not affected either for feeding live stock or as food for human consumption. Furthermore, the meal produced in this process being light-colored, and relatively undenatured since it has not been subjected to high temperatures and pressures, can be used for development of non-food products.

This process is now being operated on a pre-pilot plant scale in the Southern Laboratory, and substantial quantities of pigment glands and gland-free meal have been produced. The process is not yet ready for large scale operation, but pilot plant research will be conducted to develop a feasible commercial process utilizing this principle, and at the same time the products obtained will be qualitatively examined for possible industrial uses.

I might add at this point that those of you who are visiting the Southern Laboratory this afternoon will have an opportunity to see this process demonstrated, so that it will be clearer to you just how the separation of

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cottonseed into the pigment glands, meal, and oil is effected. I should like to mention that in addition to seeing this process demonstrated, you may also see some of the work that is being conducted there on the storage of cottonseed, in an effort to improve the quality of stored seed.

In closing I wish to take this opportunity to thank you again for the privilege of meeting with this group and speaking to you on this occasion.